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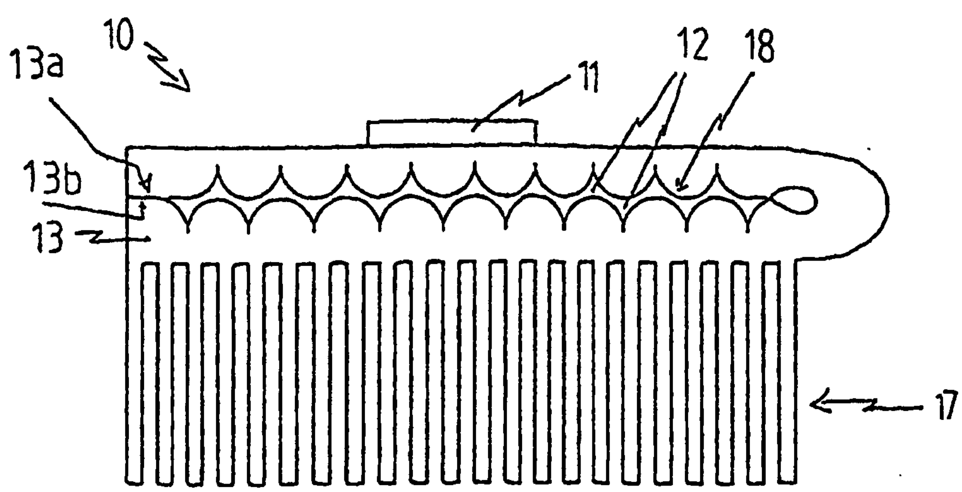

(57) Abstract

The invention relates to a heat exchanger (10) based on heat energy bound to working fluid in phase transition comprising heat exchanger elements (12) that contain working fluid for conducting elsewhere the heat energy generated by a heat source (11). The heat exchanger (10) of the invention comprises an initially one-piece heat exchanger part (13) formed in such a manner that two initially separate surface areas (13a, 13b) thereof are brought into the vicinity of one another so as to form at least one heat exchanger element (12) by the initially one-piece heat exchanger part (13). The heat exchanger (10) of the invention may preferably include heat exchanger members (17) intensifying the heat transfer capacity of the heat exchanger (10) of the invention. The invention also relates to a method for producing the heat exchanger (10) based on heat energy bound to working fluid in phase transition.

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HEAT EXCHANGER AND METHOD FOR PRODUCING THE HEAT EXCHANGER

BACKGROUND OF THE INVENTION

The invention relates to a heat exchanger based on heat energy bound to working fluid in phase transition, the heat exchanger comprising, for conducting elsewhere the heat energy generated by a heat source, heat exchanger elements containing working fluid.

The invention also relates to a method for producing a heat exchanger based on heat energy bound to working fluid in phase transition, the heat exchanger comprising, for conducting elsewhere the heat energy generated by a heat source, heat exchanger elements containing working fluid.

Heat transfer is an old and known problem, the significance of which, for example in electronics, is becoming more pronounced with increasing power and integration densities, since all electronic components generate heat, which has to be dissipated to provide an optimal and reliable operation for the components. As the field of electronics continuously progresses in a direction where increasingly high powers are processed in increasingly small volumes, the temperature control of electronic components has become a decisive planning criterion. Many current electronic appliances need cooling that cannot be achieved by conventional metallic cooling fins.

This invention is, however, not restricted to the temperature control of electronic components only, but here a heat source refers to any heat source, whose temperature needs to be controlled or whose heat energy can be utilized elsewhere.

One way of controlling temperatures, i.e. to cool or to heat, is to use heat pipes, which are becoming a more important heat transfer means in temperature control applications for heat sources.

The operation of heat pipes is based on phase transition of a liquid working fluid in an evaporator, and on vapour moving to a condenser where the vapour condenses back to liquid. The condensed liquid working fluid is driven by capillary force back to the evaporator by means of a particular wick structure. Another alternative to bring the condensed working fluid back to the evaporator is to use gravity. Evaporation occurs by utilizing the heat energy generated by the heat source, and condensation is accomplished in such a manner that the condenser end of the heat pipe is in a colder state, which is why the vapour emits its latent heat obtained by evaporation and condenses to

liquid. Since the latent heat bound to evaporation is particularly high and the mass transfer is rapid, the heat pipes provide heat exchange powers of a totally different category than the exchangers based on heat conduction. Conventionally each heat source has had a separate heat pipe.

Recently, particular micro heat pipes have emerged along with conventional heat pipes. The dimensions of micro heat pipes are generally small, typically in the 2-3 millimetre range. The working fluid returns as a liquid from a condenser to an evaporator, driven by capillary force, also in micro heat pipes. The capillary force in micro heat pipes is caused by sharp corners inside the micro heat pipes in contrast to a separate wick structure in conventional pipes.

So far there are only a few different models of micro heat pipes. Micro heat pipes typically have simple triangular or square cross sections. It is essential that the structure includes, for example corners, which are small enough to drive the capillary forces to the liquid working fluid. Said portions are arranged between the micro heat pipe ends, and serve to transfer the liquid working fluid to be evaporated back from the condenser end to the evaporator end for evaporation. At the same time, the micro heat pipe has to include a free vapour channel.

A heat exchanger structure using micro heat pipes is such where the base material comprises a plurality of parallel micro heat pipes placed apart. Such a solution is presented in US patent 5 527 588 describing a micro heat pipe panel and a method for producing it.

A problem with the above described arrangement is that such a heat exchanger using micro heat pipes usually comprises only a small number of micro heat pipes. As a result, a heat exchanger using such micro heat pipes may use a relatively small amount of working fluid. This may result in a situation where working fluid is no longer returned to the evaporator, i.e. a dryout is achieved. When such a situation occurs, the micro heat pipe stops functioning as desired, i.e. it can no longer dissipate the heat energy generated by the heat source.

A corresponding situation occurs when a single micro heat pipe simply comprises too few such portions that transfer working fluid from the condenser end back to the evaporator, i.e. direct capillary force to the working fluid.

In addition to temperature control, heat pipes can also be utilized, for example, in thermostat, heat diode and thermostatic switch applications.

The heat exchanger of the invention is also applicable to be used in such applications.

BRIEF DESCRIPTION OF THE INVENTION

It is an object of the invention to provide a heat exchanger to solve the above problems.

The objects of the invention are achieved with a heat exchanger, characterized by what is claimed in the characterizing part of independent claim 1.

The preferred embodiments of the invention are disclosed in the dependent claims 2 - 11.

The invention also relates to a method according to claim 12 for producing a heat exchanger.

The preferred embodiments of the manufacturing method are disclosed in the dependent claims 13 - 17.

The heat exchanger of the invention provides the advantage that in heat exchanger elements, such as micro heat pipes, the structure of the heat exchanger allows a larger number of such portions that direct capillary force to a liquid working fluid compared with a heat exchanger equal in size using conventional micro heat pipes. As a result, the dryout, where working fluid is no longer returned to the evaporator and the heat exchanger stops functioning, is not exceeded until higher heat transfer powers are used.

Another advantage achieved with the heat exchanger of the invention is that the advantageous structure thereof enables a larger number of heat exchanger elements per unit volume, and consequently more working fluid transferring heat energy can be used in the heat exchanger of the invention than in a conventional heat exchanger.

A further advantage achieved with the heat exchanger of the invention is that, since it may contain more heat exchanger elements per unit volume than a conventional heat exchanger, the heat exchanger of the invention can be made smaller in size than a conventional heat exchanger and still achieve the transfer capacity of a conventional heat exchanger. This is a great advantage particularly in compact devices, where it has previously been impossible to use heat exchangers owing to the their large size. Small size is also an advantage in devices where heat transfer pipes are used for other purposes than actual heat transfer, such as thermostats, heat diodes and

thermostatic switches.

Another advantage achieved with the heat exchanger of the invention is that the production technique thereof is simple. For example processing, moulding, casting, or sintering can provide the surfaces with such shapes that cause a capillary force to the working fluid. Initially separate surfaces of such initially one-piece heat exchanger parts can easily be brought into the vicinity of one another so as to form heat exchanger elements.

A further advantage achieved with a preferred embodiment of the heat exchanger of the invention is that since it comprises at least one initially integral cavity and that the surface areas brought into the vicinity of one another are on the inner surface of said at least one cavity. Such cavities can easily be formed, for example, by pressing them between two instruments in such a manner that the initially at least two separate surface areas are brought into the vicinity of one another, whereby at least two heat exchanger elements are formed in the initially one-piece heat exchanger part.

Another advantage with a preferred embodiment of the heat exchanger of the invention is that such a heat exchanger is easy to manufacture, since the heat exchanger elements therein move substantially in parallel with one another.

A further advantage achieved with a preferred embodiment of the heat exchanger of the invention is that the heat transfer capacity of the heat exchanger improves, since it includes at least two heat exchanger elements connected to one another with at least one connecting channel, and because such an arrangement ensures that cooling or heating capacity is transferred where it is needed. The possibility to combine heat exchanger elements also makes the manufacturing of the heat exchanger of the invention easier, and consequently each heat exchanger element does not have to be separately sealed.

Another advantage with a preferred embodiment of the heat exchanger of the invention is that the heat transfer capacity of the heat exchanger of the invention improves, since it comprises heat exchanger members arranged to emit the heat energy of the heat exchanger elements conducted to the condensers into the environment, and because the capillary force becomes more effective as the working fluid condenses more rapidly back to liquid from the vapour phase.

A further advantage achieved with a preferred embodiment of the

heat exchanger of the invention is that, since the heat exchanger members therein are air cooling members preferably integrated into the heat exchanger in such a manner that an initially one-piece heat exchanger part and air cooling members form an integral unit, the heat transfer capacity of said initially one-piece heat exchanger part improves, thus strengthening the operation of the heat exchanger of the invention. This is due to the fact that said initially one-piece heat exchanger part and correspondingly also the heat exchanger have in this preferred embodiment plenty of common interface, from which the warmer heat exchanger part can emit heat energy into a colder environment. Alternatively, liquid cooling members may also function as heat exchanger members, in which case the operation of the heat exchanger of the invention is strengthened by liquid cooling.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following the invention will be described in greater detail by means of the preferred embodiments with reference to the accompanying drawings, in which

Figure 1 shows how a heat exchanger of the invention is formed of a board-like initially one-piece heat exchanger part,

Figure 2 shows a cross section of a heat exchanger of the invention comprising heat exchanger members,

Figure 3 shows how a heat exchanger of the invention comprising two heat exchanger elements can be formed of one initially one-piece heat exchanger part including a cavity,

Figure 4 shows how a heat exchanger of the invention comprising multiple heat exchanger elements can be formed from one initially one-piece heat exchanger part including a cavity, and

Figure 5 shows how an initially one-piece heat exchanger part including a cavity can be connected to a base material by compressing it against a mould, thus forming a heat exchanger of the invention thereto.

DETAILED DESCRIPTION OF THE INVENTION

A heat exchanger 10 of the invention is a heat exchanger based on heat energy bound to working fluid in phase transition.

The heat exchanger 10 comprises heat exchanger elements 12 containing working fluid (not shown in the Figure) for conducting elsewhere the

heat generated by a heat source 11.

Here, conducting heat elsewhere refers to dissipating heat energy from the heat source 11 in general. Naturally there may be more than one heat sources 11.

The heat exchanger 10 of the invention comprises an initially one-piece heat exchanger part 13 formed in such a manner that at least two initially separate surface areas 13a, 13b thereof are brought into the vicinity of one another so as to form at least one heat exchanger element 12 by the initially one-piece heat exchanger part 13.

The heat exchanger of the invention 10 is preferably formed of one initially one-piece heat exchanger part 13. This facilitates the manufacturing of the heat exchanger of the invention 10 since the number of parts to be connected is minimized.

Figure 1 shows how a heat exchanger (10) of the invention is formed of one board-like initially one-piece heat exchanger part (13).

The material of the initially one-piece heat exchanger part 13 should be such that the initially one-piece heat exchanger parts 13 made thereof can be moulded. A good thermal conductivity is also a preferable property.

In principle, any substance capable of evaporating owing to the effect of lost heat generated by the heat source can be used as working fluid. The most typical working fluid is water, the liquid phase transition of which occurs in a very appropriate range 0 - 100°C regarding, for example, the temperature control of electronic components. In addition, water has a very high evaporation heat, i.e. a small amount of water can bind a lot of heat energy.

Alternatively high temperature liquid metals (K, Na), cryogenic liquid gases (H_2, N_2), alcohol, ammonia or freon can be used as working fluid. There are also other alternatives. The choice of working fluid also depends on the material of the initially one-piece heat exchanger part 13.

The heat exchanger elements 12 have two ends. The end close to the heat source 11 is called an evaporator and the opposite end a condenser. In the evaporator end a liquid working fluid (not shown in the Figure) evaporates into gas and binds evaporation heat, or latent heat, characteristic of the medium to itself. The lost heat generated by the heat source 11 provides the evaporation of said liquid working fluid. Evaporation causes a pressure gradient in the heat exchanger element 12 forcing the evaporated working fluid to flow to the opposite end. The vapour is adiabatically conveyed, whereby the

variations in pressure and temperature are small. In the condenser the vapour condenses back into liquid, conveying the evaporation heat to the condenser. The condenser end should be placed in a colder location than the evaporator end so that said evaporated working fluid is conveyed to the condenser end, where it condenses back into liquid working fluid. The working fluid is returned in liquid form to the evaporator end along sharp angles or the like formed on the walls of the heat exchanger element 12 and causing a capillary force to the liquid working fluid. These sharp angles or the like are arranged between the evaporator end and the condenser end in the heat exchanger element 12. It is essential that the heat exchanger element 12 comprises such portions as angles, corners or the like that are small enough to direct the capillary forces to the liquid working fluid. At the same time, the heat exchanger element 12 must include a free vapour channel. The basic function of the heat exchanger element 12 is known in the prior art and will therefore not be explained here in greater detail.

At least one heat exchanger channel 14 is preferably formed on the heat exchanger part 13. Here the heat exchanger channel 14 refers to an open structure.

The heat exchanger channel 14 is preferably a groove or the like on the surface of the initially one-piece heat exchanger part 13. Alternatively, the heat exchanger channel 14 may also be a groove or the like on the edge of the one-piece heat exchanger part 13. The heat exchanger channel 14 can alternatively be different than the one in the Figure and be placed in another location on the initially one-piece heat exchanger part 13.

The initially one-piece heat exchanger part 13 may also preferably comprise at least one initially integral cavity 15. Then said at least two initially separate surface areas 13a, 13b are inside said at least one integral cavity 15. There may, of course, be more than one initially integral cavities 15.

Figure 3 shows the initially one-piece heat exchanger part 13, whose initially integral cavity 15 is formed in such a manner that at least two initially separate surface areas 13a, 13b are brought into the vicinity of one another so as to form two heat exchanger elements 12 on the initially one-piece heat exchanger part 13.

Correspondingly by bringing multiple initially separate surface areas 13a, 13b of the initially integral cavity 15 into the vicinity of one another as shown in Figure 4, there will be several heat exchanger elements 12 in the

tubular one-piece heat exchanger part 13.

The initially one-piece heat exchanger part 13 in Figures 3 and 4 can also preferably be moulded in such a manner that one side becomes even, which is why the heat source 11 can easily be connected thereto.

Although Figures 3 - 5 show substantially circular initially one-piece heat exchanger parts 13 in cross section, the initially one-piece heat exchanger part 13 may naturally have a different cross section.

The initially separate surface areas 13a, 13b of the initially integral cavity 15 can preferably be brought into the vicinity of one another, for example, by pressing the initially one-piece heat exchanger part 13 between two instruments 16 as shown in Figure 4.

It is of course possible that the heat exchanger 10 of the invention comprises such heat exchanger elements 12, the structure of which corresponds with the structure of a conventional micro heat pipe and/or that conventional heat pipes are used therein.

By moulding initially separate areas 13a, 13b into the vicinity of one another, they may also, if needed, be connected together preferably by gluing, welding or fusing. There are also other possible connection methods. When selecting a connection method it is important that it can provide a close connection. Individual heat exchanger elements 12 can in some cases be connected together, but the heat exchanger elements 12 should be separated from the environment.

The heat exchanger 10 of the invention preferably comprises heat exchanger members 17 arranged to emit heat energy conducted to the condenser area into the environment.

The heat exchanger 10 of the invention preferably comprises heat exchanger members 17 arranged to emit heat energy conducted to the heat exchanger 10 into the environment.

Heat exchanger members 17 are preferably air cooling members integrated into the heat exchanger 10. In Figure 2 the air cooling members are fins preferably made into one integral unit together with said initially one-piece heat exchanger part 13 so as to form an integral unit. Then there is more interface between the heat exchanger 10 and the environment. Through the interface the heat exchanger 10 emits the heat energy conducted thereto into the environment; the heat transfer capacity of the heat exchanger 10 thus being more efficient.

The heat exchanger members 17 may also be liquid cooling members, in which case the heat exchanger 10 is cooled using a coolant.

The heat exchanger 10 of the invention preferably also comprises at least one connecting channel 18 connecting at least two heat exchanger elements 12.

The aim of this at least one connecting channel 18 is to divide the heat transfer capacity more advantageously, the heat transfer capacity then being transferred where it is needed. Production technically, this also facilitates the manufacturing of the heat exchanger 10 of the invention, since each heat exchanger element 12 does not have to be sealed separately.

Alternatively, all heat exchanger elements 12 can be connected together in such a way that there is only one single substantially integral cavity (not shown in the Figure) inside the heat exchanger 10. This is also possible as long as said cavity includes an adequate number of such portions that direct capillary force to the working fluid.

The heat exchanger elements 12 can be placed in various ways, for example, so that the heat exchanger elements 12 move substantially in parallel from the heat source 11. The heat exchanger elements 12 may preferably also be placed in parallel against the circuit board level.

The heat exchanger elements 12 may, for example, also be placed so as to deliver the working fluid to a particular point for cooling.

Alternatively the heat exchanger elements 12 can be placed in such a manner that the heat exchanger elements 12 move two or three-dimensionally from the heat source 11.

The heat exchanger 10 of the invention can be connected to the heat source 11 in various ways. What is most important is that the thermal contact between the heat source 11 and the heat exchanger 10 is as good as possible. Conventional thermal mediums can be used to improve thermal contact.

Figure 5 shows how the tubular initially one-piece heat exchanger part 13 can be pressed into a moulded recess 20 made in the base material 19, in which case the heat exchanger 10 of the invention is provided in the base material 19. A particularly good thermal contact is thus provided between the heat exchanger element 12 and the base material 19.

The invention also relates to a method for producing the heat exchanger 10 based on heat energy bound to working fluid in phase transition,

the heat exchanger 10 comprising the heat exchanger elements 12 containing working fluid for conducting elsewhere the heat energy generated by the heat source 11.

The method comprises at least the phases where the initially one-piece heat exchanger part 13 is arranged, the one-piece heat exchanger part 13 is formed in such a manner that at least two separate surface areas 13a, 13b thereof are brought into the vicinity of one another so as to form at least one heat exchanger element 12 on the one-piece heat exchanger part 13. This is shown, for example, in Figure 1.

The heat exchanger element 12 is thereafter filled at least partly with working fluid and hermetically closed. This means that the heat exchanger element is closed in such a way that no materials are allowed in or out thereof. The heat energy should, however, be able to move from the heat source 11 to the heat exchanger element 12 in the evaporator end thereof and away from the heat exchanger element 12 in the condenser end thereof.

The phases of the method of the invention can alternatively be performed in a different order.

The surface of the heat exchanger part 13 can preferably be machined before the one-piece heat exchanger part 13 is formed, whereby more such portions, as sharp corners directing capillary force to the working fluid, are provided in the formed heat exchanger elements 12. Machining may preferably provide, for example, heat exchanger channels 14, shown in Figure 1.

Figure 3 shows how the one-piece heat exchanger part 13 comprising an integral cavity 15 is formed in such a manner that the two separate surface areas 13a, 13b inside the integral cavity 15 are brought into the vicinity of one another so as to form two heat exchanger elements 12 on the one-piece heat exchanger part. Naturally there may be more than two separate surface areas 13a, 13b. There may also be several integral cavities 15.

The one-piece heat exchanger part 13 can preferably be formed by pressing it between two instruments 16, as shown in Figure 4. There may, of course, be more than two such instruments 16. At least one of the instruments 16 has an even working surface, in which case an even mounting surface (not shown in the Figure) is formed on the heat exchanger for the heat source 11.

A substance at least partly resisting the compression of the cavity 15 is preferably placed in at least one integral cavity 15. When selecting such a substance and considering the degree of admission of the cavity, the reduc-

tion in cavity size should be taken into account when forming it.

The one-piece heat exchanger part 13 can preferably also be formed by hydraulic forming. Such hydraulic forming methods are known by the trade names Vari-Form and Hydroform. Such manufacturing methods as fringing, extrusion or rolling can preferably be used in manufacturing the one-piece heat exchanger part 13.

The one-piece heat exchanger part 13 can also be formed by using a combination of various manufacturing methods, for example forming methods.

It is clear for those skilled in the art that the above manufacturing methods are merely examples of suitable methods, and that there are other suitable manufacturing methods.

It is obvious for those skilled in the art that as technology advances the basic idea of the invention can be implemented in various ways. The invention and its embodiments are thus not restricted to the above examples but may vary within the scope of the attached claims.

CLAIMS

1. A heat exchanger (10) based on heat energy bound to working fluid in phase transition, the heat exchanger (10) comprising, for conducting elsewhere the heat energy generated by a heat source (11),

heat exchanger elements (12) containing working fluid

characterized by

comprising an initially one-piece heat exchanger part (13) formed in such a manner that at least two initially separate surface areas (13a, 13b) thereof are brought into the vicinity of one another so as to form at least one heat exchanger element (12) by the initially one-piece heat exchanger part (13).

2. A heat exchanger as claimed in claim 1, **characterized** in that at least one heat exchanger channel (14) is formed in the initially one-piece heat exchanger part (13).

3. A heat exchanger as claimed in claim 2, **characterized** in that the heat exchanger channel (14) is a groove or the like.

4. A heat exchanger as claimed in claim 1, **characterized** in that the heat exchanger (10) is formed of one initially one-piece heat exchanger part (13).

5. A heat exchanger as claimed in claim 1, **characterized** in that the initially one-piece heat exchanger part (13) comprises at least one initially integral cavity (15) and that said at least two initially separate surface areas (13a, 13b) are inside said at least one integral cavity (15).

6. A heat exchanger as claimed in claim 5, **characterized** in that the initially one-piece heat exchanger part (13) is shaped as a tube.

7. A heat exchanger as claimed in claim 1, **characterized** in that the heat exchanger (10) comprises heat exchanger members (17) arranged to emit heat energy conducted to the heat exchanger (10) further into the environment.

8. A heat exchanger as claimed in claim 7, **characterized** in that the heat exchanger members (17) are air cooling members integrated into the heat exchanger (10).

9. A heat exchanger as claimed in claim 7, **characterized** in that the heat exchanger members (17) are liquid cooling members.

10. A heat exchanger as claimed in claim 1, **characterized** in that the heat exchanger has at least one connecting channel (18) connect-

ing at least two heat exchanger elements (12).

11. A heat exchanger as claimed in claim 1, **characterized** in that the heat exchanger elements (12) are substantially parallel.

12. A method for producing a heat exchanger (10) based on heat energy bound to working fluid in phase transition, the heat exchanger (10) comprising, for conducting elsewhere the heat energy generated by a heat source (11),

heat exchanger elements (12) containing working fluid

characterized by comprising at least the following steps

arranging an initially one-piece heat exchanger part (13)

forming a one-piece heat exchanger part (13) in such a manner that at least two initially separate surface areas (13a, 13b) thereof are brought into the vicinity of one another so as to form at least one heat exchanger element (12) of the initially one-piece heat exchanger part (13),

filling the heat exchanger part (12) at least partly with working fluid, and

closing the heat exchanger element (12) tightly.

13. A method as claimed in claim 12, **characterized** by

arranging the one-piece heat exchanger part (13) comprising at least one integral cavity (15),

forming the one-piece heat exchanger part (13) in such a manner that the at least two separate surface areas (13a, 13b) inside said at least one integral cavity (15) are brought into the vicinity of one another so as to form at least two heat exchanger elements (12) of the one-piece heat exchanger part (13).

14. A method as claimed in claim 13, **characterized** in that a substance at least partly resisting the concentration of the cavity (15) is placed in at least one integral cavity (15).

15. A method as claimed in claim 12, **characterized** in that the one-piece heat exchanger part (13) is formed by pressing it between at least two instruments (16).

16. A method as claimed in claim 12, **characterized** in that the one-piece heat exchanger part (13) is formed by hydraulic forming.

17. A method as claimed in claim 12, **characterized** in that the surface of the one-piece heat exchanger part (13) is processed before forming the one-piece heat exchanger part (13).

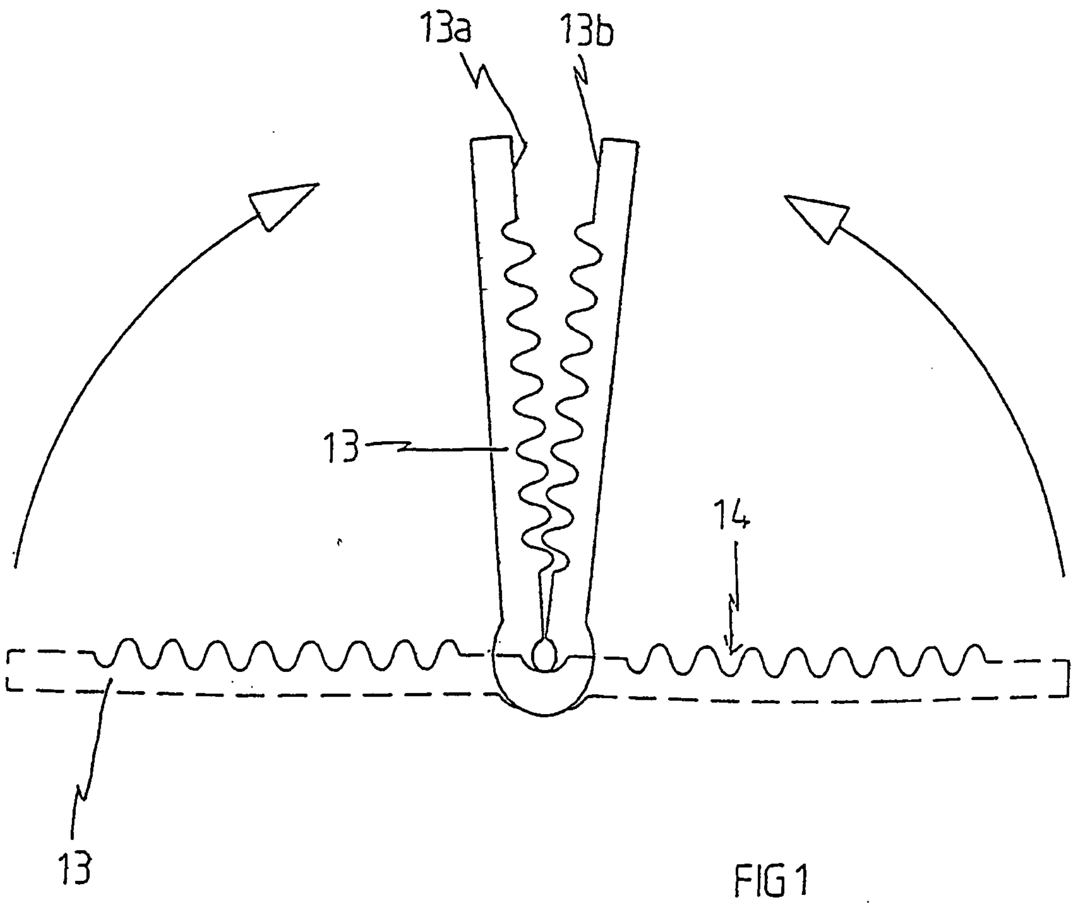

FIG 1

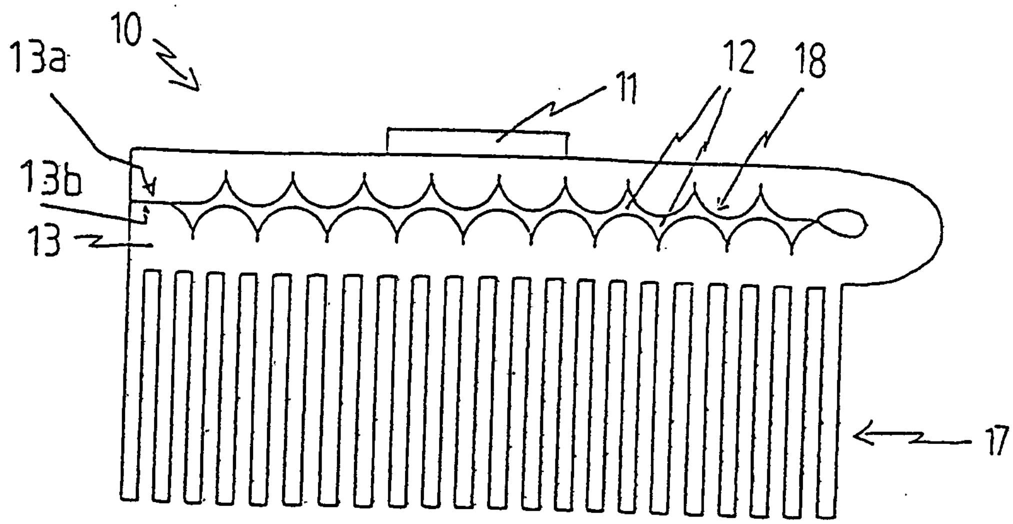

FIG 2

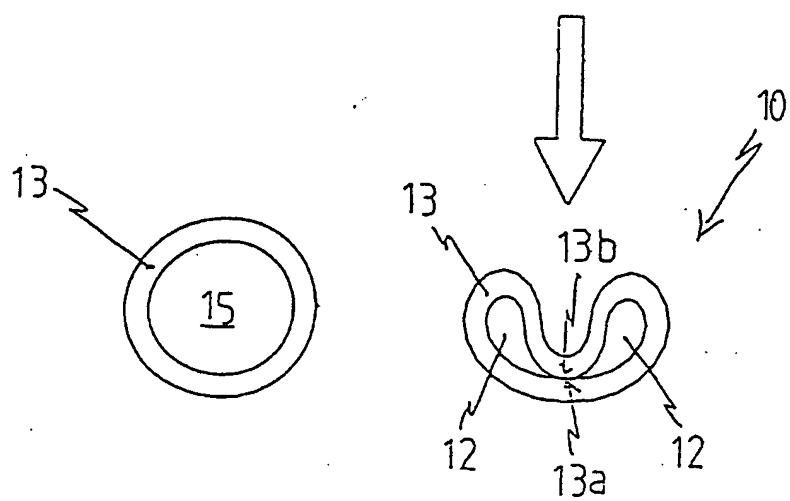

FIG 3

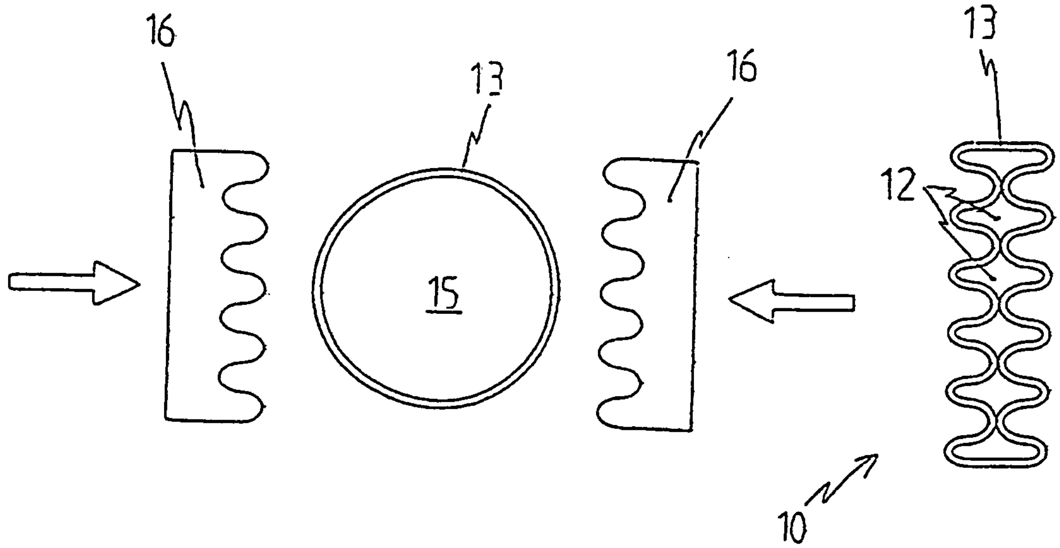

FIG 4

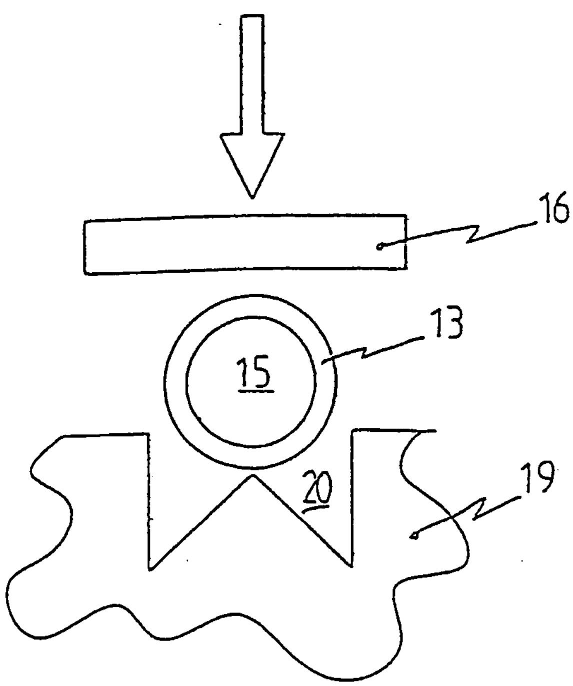

FIG 5

INTERNATIONAL SEARCH REPORT

International application No.
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A. CLASSIFICATION OF SUBJECT MATTER

IPC6: F28D 15/02, B32B 31/00 // B32B 31/02, H05K 7/20, H01L 23/427

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: F28D, H05K, H01L, B32B, B21D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4279294 A (FITZPATRICK ET AL), 21 July 1981 (21.07.81), c.f. Figs. 1,7,8 --	1,2,5,6,12, 13
X	WO 9526125 A1 (AAVID LABORATORIES, INC.), 28 Sept 1995 (28.09.95), c.f. Figs. 2,3 (detail (37)), 5,6 --	1,4,7-9,12
A	DE 3117758 A1 (TELEFONAKTIEBOLAGET LM ERICSSON), 21 January 1982 (21.01.82) --	8
A	Patent Abstracts of Japan, abstract of JP 63-115351 A (FUJIKURA LTD), 19 May 1988 (19.05.88) --	

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" erlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 May 1999	14 -06- 1999

Name and mailing address of the ISA/	Authorized officer
Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Annette Riedel Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 99/00131

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4503906 A (ANDRES ET AL), 12 March 1985 (12.03.85) --	
A	US 5044429 A (SAKAYA ET AL), 3 Sept 1991 (03.09.91) --	
A	US 5314010 A (SAKAYA ET AL), 24 May 1994 (24.05.94) -- --------	

INTERNATIONAL SEARCH REPORT

Information on patent family members

03/05/99

International application No.
PCT/FI 99/00131

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